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AUTHOR Vogel, Irene
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ABSTRACT

The language of the deaf has only recently become an area of concern for linguists. Of special interest are questions of the systematicity of deaf speech (is it systematic or idiosyncratic and none-rule-governed?) and the nature of its deviation from the speech of hearing people. The study presented here is an effort on the part of linguists, first of all, to analyze one aspect of the language, the phonology, of a deaf child, and secondly, to propose a method for improving the speech of the child based on knowledge of normal patterns of phonology acquisition. An analysis of the phonology of Emma, a profoundly deaf English child (age 11;9) is presented in this paper, and it is demonstrated that the child's speech is indeed systematic and rule-governed, though the system is by no means that of standard English. The ways is which Emma's speech deviates from the standard are also examined, comparing her patterns with universal and English patterns. Finally, a proposal for therapy is made based on facts of normal phonology acquisition and the notion that deaf speech is, in fact, systematic. (Author/NCR)

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DEAF PHONOLOGY: A CASE STUDY OF AN ENGLISH CHILD

Irene Vogel
Stanford University
and
The University of London

ABSTRACT

The language of the deaf has only recently become an area of concern for linguists. Of special interest are questions of the systematicity of deaf speech (is it systematic or idiosyncratic and none-rule-governed?) and the nature of its deviation from the speech of hearing people. An analysis of the phonology of Emma, a profoundly deaf English child (age 11;9) is presented in this paper and it is demonstrated that the child's speech is indeed systematic and rule-governed, though the system is by no means that of standard English. The ways in which Emma's speech deviates from the standard are also examined. Finally, a proposal for therapy is made based on facts of normal phonology acquisition and the notion that deaf speech is, in fact, systematic.

1. Introduction

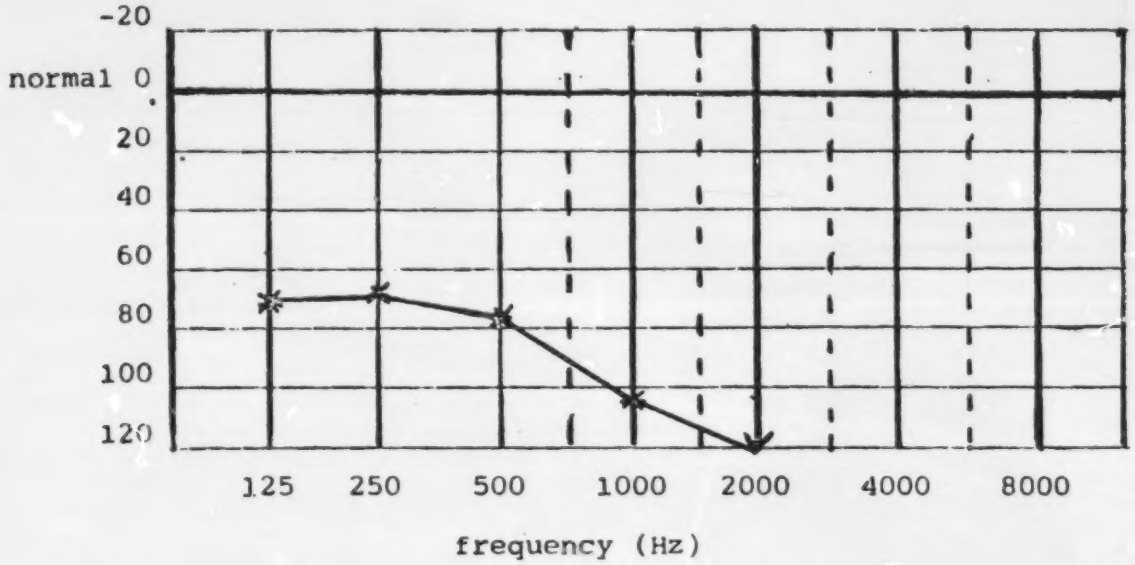
There has always been controv rsy regarding various aspects of deaf language among speech pathologists. Linguists, however, are only now gradually becoming interested in the language of the deaf. The study presented here is an effort on the part of linguists, first of all, to analyze one aspect of the language, the phonology, of a deaf child, and secondly, to propose a method for improving the speech of the child based on knowledge of normal patterns of phonology acquisition.[1]

2. The Subject

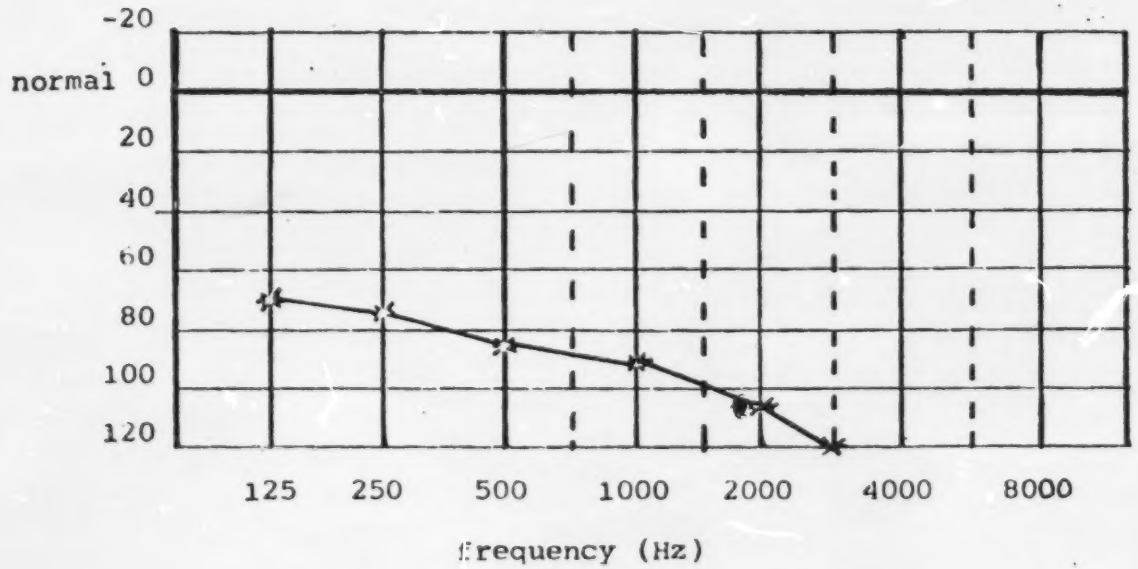
Emma, the only subject in this study at present, was diagnosed at the age of nine months as having sensory-neural deafness (i.e. deafness caused by some impairment of the sound-interpreting mechanism, as opposed to conductive deafness, caused by a defect in the mechanisms responsible for the transmission of the vibrations). Emma first came to SOAS (School of Oriental and African Studies) at the University of London in October 1975, at the age of 11;9, to be the subject of this investigation. According to her audiogram, the subject is profoundly deaf with an average loss of approximately 100 dB in the left ear and 93 dB in the right ear (see Fig. 1). This paper presents our first analysis of her speech.

FIGURE 1. Emma's audiograms

LEFT EAR



RIGHT EAR



3. The Data

Before any attempt at therapy could be made, it was necessary to analyze and assess Emma's phonological abilities. Simply stating that Emma was generally unintelligible, not only to us but also to herself when tapes of her own speech were played, does not say anything significant about her language. Was she unintelligible because her speech was idiosyncratic and unsystematic or was it because she used a system that was not the same one used by speakers of standard English, but a system none the less?

In order to make an assessment of Emma's initial speech production, we recorded Emma interacting with her mother and the three investigators very soon after she started coming to SOAS. The tapes were transcribed, with most attention paid to consonants rather than to vowels. Three types of speech were analyzed separately: spontaneous, read, and prepared. Spontaneous speech refers to utterances that Emma produced unprompted and unaided. Read speech is simply a sample of Emma's reading from a text, and prepared speech refers to the memorized answers Emma produced in response to specific questions she had been drilled on. Counts were made of the consonants which Emma used in each type of speech situation, considering syllable-initial position separately from syllable-final position.

It was more difficult to assess Emma's language perception, however. A test was devised in which Emma had to say whether two nonsense words were the same or different after hearing them on a tape. The sets of words were minimal pairs such as a:p:a: / a:b:a:, a:b:a: / a:m:a:. Either Emma did not understand the task or just did not perceive any differences at all, but in any case, she did not want to perform the task and simply answered 'same' for all the pairs after the first few. The responses to the perception test were not considered valid so the only information on the child's perception comes only from the audiogram.[2]

4. Analysis

Recent analyses of child phonology have typically been of two sorts. Either (a) the child's productions are compared to their adult models (e.g. Smith, 1973; Stampe, 1973) or (b) the child's productions are considered as a unified corpus, as a language of its own (e.g. Waterson, 1970; Ferguson and Farwell, 1975). In both cases, claims are made directly or indirectly about the child's mental organization and representation of his/her lexicon and phonology, their ultimate differences depending essentially on the relative roles of perception and production in determining the child's output. In the first case, the child's perception is considered to be fully developed very early so that non-adult articulations are due to incorrect production rules, while in the second case, the child's perception matures gradually and the productive abilities follow.

Both approaches to phonology acquisition assume that a given child receives more or less the same language input that all other children receive and that adults around him/her received as children, and should therefore naturally acquire the same or similar linguistic system as the other children and adults of the linguistic community. In the case of a profoundly deaf child, however, this assumption obviously cannot be made. If the child establishes underlying representations, it cannot be on the basis of what he/she has been hearing. Instead, such information must be used as can be gathered from lip-reading, explicit directions for positioning the articulators, learned mouth configurations corresponding to letters of the alphabet, etc. If little is known or agreed upon about the nature of underlying representations of words in normal children, or adults for that matter, even less is known about the nature of the deaf individual's linguistic organization and representation.

It is questionable whether young hearing children have their words represented in some form similar to the adult's output, but it is certainly not the case for deaf children who do not even hear the adult forms. The first type of analysis of child phonology, therefore, is obviously inappropriate here. The second type of analysis is also inappropriate for dealing with deaf language acquisition since its underlying assumption that perception precedes production as the child creates his/her system is also obviously false. Since neither of the approaches to the acquisition of phonology currently available provides an appropriate model for analysis, the alternative we found was simply to look for some internally self-consistent system or pattern of sound distribution among the utterances of the corpus in question. Given the present state of knowledge of deaf language, it does not seem possible to go beyond this type of analysis and make substantive claims about the storage of words and phonological processes used in getting from some underlying form to the actual pronunciation.

The analysis of Emma's speech that follows is an examination of her production patterns at the outset of the project. No claims are made about her perception, underlying representations, or production rules, but much can be learned simply by comparing the sounds Emma used in syllable-initial and syllable-final position, and by comparing the sounds she used in the different speech styles. Tables 1 and 2 are summaries of the distribution of syllable-initial and syllable-final consonant types.

In the light of the phonological patterns found in Emma's speech it is possible to answer the question of whether deaf speech is systematic or not. Many of the phenomena in Emma's speech are consistent with universals of phonology as well as with facts of acquisition, and even some distributional facts of English. The answer to the question must be yes, deaf speech is systematic. It obeys certain laws of natural languages, though the system is not necessarily that of the standard variety of the particular language. The following sections discuss the data presented in Tables 1 & 2 as reflections of either Universal patterns, English patterns or Emma's patterns.

TABLE 1. Summary of syllable-initial consonant distribution

consonant	spontaneous	read	prepared	sub-total*	total**
p	13	10	12	35	49
t	13	7	6	27	45
k	20	14	5	39	42
b	16	3	4	23	36
d	13	22	17	52	68
g	2	7	2	11	13
ɸ	4	3	8	15	19
ɓ	-	-	3	3	4
m	1	2	5	8	10
n	-	2	-	2	6
f	5	-	2	7	9
v	5	2	-	7	9
h	10	4	5	19	20
ɦ	2	1	5	8	9
l	1	-	-	1	1
r	-	-	-	-	1
w	-	-	-	-	1
j	1	-	-	1	3
θ	-	1	-	1	2
ð	1	-	1	2	4
s	1	-	-	1	1
ʃ	-	1	-	1	1
ʔl	-	2	1	3	3
n̂l	-	1	-	1	1
ʰl	-	-	2	2	3
pl	1	-	-	1	1
	99	82	78	259	361

* total of consonants found in the three types of speech (i.e. spontaneous, read, prepared).

** total of consonant tokens found in entire corpus including those items that could not be glossed, as well as the three types of interpreted speech.

ɸ = voiceless labio-dental stop

ɓ = voiced labio-dental stop

ɦ = voiced h

ʔl = concurrent lateral and glottal stop articulation

n̂l = concurrent lateral and nasal articulation

ʰl = concurrent lateral and aspirated articulation

TABLE 2. Summary of syllable-final consonant distribution [a]

consonant	spontaneous	read	prepared	sub-total*	total**
p	2	2	-	4	6
t	2	3	2	7	10
k	9	6	-	15	16
b	1	4	4	9	9
d	20	6	25	51	69
g	5	3	4	12	19
m	2	-	-	2	2
n	-	5	1	6	15
l	3	4	4	11	12
r	-	1	-	1	1
s	-	3	-	3	3
z	-	1	1	2	2
ʃ	-	1	-	1	1
ɣ	-	-	3	3	3
ts	-	4	-	4	4
ds	-	3	-	3	3
ls	-	1	-	1	1
mp	-	1	-	1	1
gf	-	1	-	1	1
gm	-	1	-	1	1
nts	-	1	-	1	1
ntʃ	-	1	-	1	1
nθs	-	-	-	-	1
tʃ	-	-	-	-	1
f̬p	-	-	-	-	1
v	-	-	-	-	1
ç	-	-	-	-	1
	44	52	44	140	191

[a] Notes for Table 1 apply here also.

Universal Patterns

Patterns (a) - (e), below, all represent phonological universals and universals of acquisition.

(a) There are almost twice as many syllable-initial consonants as syllable-final ones.

(b) In both syllable positions, the number of stops represents well over half of the total number of consonants (approximately 76% of the syllable-initial consonants and 68% of the syllable-final consonants).

(c) Glides (w, j), liquids (l, r), fricatives (f, v, s, z, θ, ð, ʃ, ʒ) and affricates (tʃ, dʒ) are rare.

(d) In both initial and final positions, the alveolar stops are the most common stops (i.e. 113 syllable-initially and 79 syllable-finally to 85 bilabials initially and 15 finally and to 55 velars initially and 35 finally).

(e) In syllable-initial position velars are the rarest of the stops and in syllable-final position bilabials are the rarest.

Since CV is considered the basic syllable type, it is not unusual to find almost twice as many consonants in syllable-initial position as in syllable-final position (a). Emma's frequent use of stops and rare use of liquids, glides, fricatives and affricates are consistent with the notion that stops are the least marked manner of articulation for consonants and that stops are generally acquired earlier than other types of consonants (b and c). The apical articulation is often considered to be the most basic (cf. Chomsky and Halle, 1968), and in Emma's speech there are clearly more apical consonants than other types (d). According to Ingram's (1974) notion of fronting, which he suggests is a universal process of phonology acquisition, "back consonants are less marked in syllable final position than in syllable initial position and vice versa for front consonants." (233). In Emma's speech, more syllables begin with bilabials than with velars, but more syllables end with velars than with bilabials (e).

English Patterns

Patterns (f) - (h) seem to reflect distributional facts of English though fact (f) is actually a combination of a universal tendency and a fact of English.

(f) In syllable-initial position, spontaneous speech contains more consonants than the other two categories, whereas in the case of syllable-final position, the read speech contains the largest number of consonants.

(g) In syllable-initial position, h's (h and ɦ) are quite common but in syllable-final position they are non-existent.

(h) There are many more consonant clusters in syllable-final position than in syllable-initial position.

Delattre (1965) has reported an overall distribution of 60% closed syllables to 40% open syllables in English, hence Emma's large number of syllable-final consonants in read speech (f). The fact that syllable-initial position contains more consonants in spontaneous speech, though not consistent with general distributions in English, is consistent, however, with the universal preference for the CV syllable type and the tendency in less formal speech to delete consonants or simplify clusters in less careful styles of speech (e.g. -r in New York English Labov, 1968). The /h/ in English occurs only in syllable-initial position and similarly in Emma's speech (g). Also, English has more complex consonant clusters in syllable-final position than it has in syllable-initial position (cf. [fIfθs] fifths, but *[fθs__]). Similarly, Emma uses more clusters finally than initially.

One must be rather cautious, however, in attributing these facts solely to Emma's knowledge of English phonology. The occurrence of h's in Emma's speech could also be interpreted as breathy onset in many cases due to a lack of breath control, a commonly found characteristic of deaf speech. Also, facts (f) and (h) together hint that although Emma does at times produce complex syllable-final clusters, they may not actually be part of her own linguistic system and knowledge of English, but rather a direct motor response to other types of stimuli (e.g. the written word or explicit articulatory directions).

Emma's Pattern

(i) Nasals are rare both syllable-initially and syllable-finally (though nasalization often accompanies vowels and some consonants in Emma's speech).

The infrequent use of nasals (i) is unusual since nasals are very common in the world's languages (cf. Ferguson, 1975) and are generally among the first sounds children acquire. Although there is some redundant nasalization of vowels before nasal consonants in English (cf. Clumeck, 1975) and there are some dialects that tend to be somewhat "nasal", the heavy nasalization used by Emma is not systematic in these ways. Thus, it is neither consistent with universal patterns nor with facts of English. Rather, Emma's nasalization indicates a lack of control of the velum, another characteristic of deaf speech in general.

It is striking that Emma's speech patterns are so systematic and that so many of the phenomena found in her speech are consistent with language universals, despite (i) above. In fact, one may wonder what is really deviant about this child's speech. Actually, it is necessary to hear only a short sample of her speech to know that there is a great deal wrong with it. As mentioned above, the breath and velum control are far from being normal, giving the speech very breathy and nasal qualities. Furthermore, universal patterns are not all that constitutes any given language. Finally, Emma is almost twelve years old and even if her speech were completely consistent with what is known about universals and normal development, at this age it would not be normal.

5. Therapy

Since the perception side of Emma's language remains largely an unknown, the therapy proposed is aimed at improving her production. It is clear that her consonant inventory is quite limited, as seen most significantly in her spontaneous speech. Although Emma produces more types of consonants in her read and prepared speech, this should only be taken as an indication that she is physiologically capable of performing certain articulations. It does not mean that they are part of her productive linguistic competence since she does not use them in her own spontaneously generated speech. The goal of our therapy is not to teach Emma how to articulate various sounds, a common goal of other types of therapy, but rather to make the articulation of the sounds automatic so that Emma can use them at will both in words she knows and in new words she encounters.

Deaf children have been found to begin babbling at the same age as normal children, but they stop quite soon thereafter (Wolff, 1973). Although the exact role babbling plays in language acquisition is unknown, it is undoubtedly important.

> An artist may spend much time drawing eggs or cylinders as a means of discovering the most effective way of showing their three-dimensional quality. He may experiment with different kinds of shading, stippling or cross-hatching. He expects that the skills he develops in these experiments and exercises will help in producing portraits, landscapes, etc. (Wolff, 1973: 113)

The sound play characteristic of the babbling scage, by which the child practices different articulations, is apparently dependent on auditory feedback. The normal child gets this feedback and goes on babbling and then speaking but the deaf child who lacks the feedback stops babbling and does not usually go on to speak. The deaf child never exercises his/her articulatory apparatus and without mastering the subskills the child cannot learn to perform the full complicated act of speaking.

The method used to help Emma develop automatic control of her articulation is very much related to the notion of babbling. Rather than starting with either whole words or sounds in isolation, Emma is asked to produce simple (V:)C:V:V:V: sequences, much as a child would do when babbling. The first sequence she worked on was a:h:a:h:a:, a contrast of aspiration and voice, to work on breath control, although this is not known to happen in babbling. Next, contrasts more typical of babbling are gradually introduced (A:b:a:, a:d:a:, a:g:a, etc.) and are repeated as many times as possible. Gradual is the key here. Language acquisition takes years at a time when the child has little else to worry about, so one should not expect a deaf person to learn to speak over night, no matter how good the therapy method is. Gross contrasts must be practiced and learned before finer contrasts are

introduced, consistent with the general orders of acquisition of sounds described by Jakobson (1941) and Waterson (1970, 1971). The order that contrasts will be introduced is as follows:[3]

(1)	voice - aspiration	(a:h:a:)
(2)	vowel - plosive	(a:b:a:, a:d:a:, a:g:a:, etc. and combinations)
(3)	vowel - nasal stop	(a:m:a:, a:n:a:, a:ŋ:a:, etc. and combinations)
(4)	open - close (vowels)	(a:i:)
(5)	spread - rounded (vowels)	(i:u:)
(6)	vowel - voiced plosive	(a:b:a:, a:d:a:, a:g:a:, etc.)
	vowel - voiceless plosive	(a:p:a:, a:t:a:, a:k:a:, etc.)
(7)	fricatives - plosives	(a:s:a:, a:t:a:, a:z:a:, a:d:a:, etc.)
(8)	affricate - fricative-plosive	(a:tʃ:a:, a:ʃ:a:, a:t:a:, etc.)
(9)	semivowels - vowels	(a:w:a:, a:j:a:)
(10)	liquids - vowels	(a:l:a:, a:r:a:)
(11)	contrasts with mid vowels and other vowels	

Any kind of information is used to teach Emma how to articulate the target sound. This includes demonstrating, writing, drawing pictures, having Emma feel the experimenter's nose, throat, breath, etc. to compare with her own, etc. She then practices the sound and is given positive and negative feedback to tell her whether she is correct. Only one contrast is practiced at a time until it is mastered. For example, if Emma is learning to produce V:b:V:, the quality of the vowel is ignored and she is not corrected if she says a:b:ɛ:b:e:b:a:, etc. as long as the b: is correct and there is a vowel present, regardless of its quality. Once several contrasts are acquired, they are combined to make more complex patterns. Thus, after Emma mastered V:b:V:, V:d:V:, V:g:V:, she practiced combining them: V:b:V:d:V, V:b:V:g:V:, V:d:V:g:, V:b:V:d:V:g:V:, etc. In addition to teaching Emma to articulate the various sounds, we occasionally asked her to identify the sounds when they are played on a tape recorder or presented to her live. Simple words which use the target sounds are also occasionally presented to illustrate how the contrasts are actually used in language.

After two months of therapy, the sounds Emma was able to consistently produce were a:h:a:, a:b:a:, a:d:a:, and a:g:a:. She was often able to produce strings in which different constrasts are combined, but at times got confused doing this and had to start over with single contrasts. Although improved articulation is the primary goal of this therapy, Emma's discrimination ability seems to be improving, according to her performance on the occasional perception tasks. Most important, however, is the ability Emma is developing to correct herself. While the experimenters initially had to provide all the feedback,

telling Emma whether or not she had articulated a sound correctly, after some practice with a particular contrast, Emma is often able to stop herself and start over when she makes a mistake now.

Summary and Conclusion

Although the study reported here is only the initial stage of a longer project investigating the phonology of a deaf child and a proposal for therapy, a number of things are already clear. Deaf speech, however different from the standard language, is still rule-governed and systematic. Many of the patterns found in Emma's speech are consistent with language universals and facts of normal phonology acquisition.

Since deaf children are deprived of the articulation practice that hearing children have in the babbling stage, the therapy described here attempts to provide the child with some of what had been lost. The focus is on the gradual mastering of contrasts, gross to fine, so that they become automatic for the child. Favorable side effects of this method that have already begun to appear are the child's increasing ability to discriminate sounds and her increasing ability to self-correct.

At the present state of knowledge about deafness, it is not possible to make strong claims about deaf speakers' underlying representations and phonological processes. It is possible, however, to make certain speculations about deaf and normal linguistic organization in light of what is already known. Although the experimenters found the filtered speech they listened to difficult to decipher in the case of words out of context, they found the conversations very intelligible. Since language is highly redundant, it is quite possible that there are enough other features in the speech signal so that one could learn to discriminate sounds using alternative sets of features. It would obviously not be easy since, presumably, the optimal distinctive features are those that hearers pick up and deaf people miss. With enough training, however, it may be possible for a deaf person to learn to use alternate sets of features to facilitate speech comprehension, as Emma appears to do at times in the discrimination tasks following work on the articulation of a particular contrast.

Finally, the speech of deaf people provides some insights into the mental organization of phonology in general. Since it is possible for deaf individuals to produce without being able to perceive speech, it can be concluded that they have motor commands, perhaps in the form of something like articulatory features, stored without reference to acoustic features.

Since there exists a class of humans who speak but who do not hear speech, it is possible to go one step further and to speculate that perception and production of phonology are separable processes. Acoustic features are used in the perception aspects of speech while articulatory or motor commands are used in its production. Of course, the normal situation is one in which there is a relation between the

acoustic (perception) features and the articulatory (production) features. And in fact, the normal process of language acquisition, from babbling on, may be seen as the gradual matching up of the two systems of features. The deaf child, obviously lacks the perception side of speech and therefore has nothing to match his/her output against so language acquisition cannot procede in the normal way. Of course, much more research must be done before we are able to evaluate such speculations and to understand the nature of phonological representation and organization in both deaf and hearing speakers.

FOOTNOTES

[1] This study is being directed by Mrs. N. Waterson of the Department of Phonetics and Linguistics at the School of Oriental and African Studies of the University of London. The author worked on the project with Mrs. Waterson and Ms. Pintip Tuaycheron during the autumn, 1975, the period of time covered in this report. Further work is currently being carried out by Mrs. Waterson and Ms. Tuaycheron.

[2] Another informal experiment was carried out, not to test Emma, but rather to give the experimenters a very crude idea of what Emma could, at best, be hearing. Since Emma cannot hear sounds above 900-1000 cps, according to the audiogram, a sample of normal speech was run through a filter which blocked out all the frequencies above 900 cps. This speech sample consisted of pairs of words with some shared phonetic properties, e.g. window / finger; bucket / Bobby; crab / cart, and a short conversational passage. No claim is being made that the filtered speech is what Emma hears. Not only does she probably hear less than what was left after filtering, but there may be other types of distortion in her perception. Furthermore, she does not have all the linguistic information that a normal speaker brings to the task of decoding speech. Nevertheless, it was useful for the experimenters, all normal hearers, to listen to the filtered speech to help them appreciate some of the difficulty encountered by a deaf person. The experimenters could not understand the individual words, though they found the conversations quite intelligible.

[3] This order is flexible and open to modification if it seems that the child needs more work in certain areas before others, or seems to be trying a particular contrast on her own that was originally scheduled for later practice.

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